CLAIMS

1. A method of forming a capacitor comprising providing a conductive oxide electrode, depositing a first layer of a high dielectric constant oxide dielectric material on said conductive oxide electrode, oxidizing said conductive oxide electrode and said first layer of said high dielectric constant oxide dielectric material under oxidizing conditions, depositing a second layer of said high dielectric constant oxide dielectric material on said first layer of said high dielectric constant oxide dielectric material, and depositing an upper layer electrode on said second layer of said high dielectric constant oxide dielectric material.

2. A method as claimed in claim 1 wherein said high dielectric constant oxide dielectric material is oxidized using a gas plasma.

3. A method as claimed in claim 2 wherein said gas plasma is formed from a gas selected from the group consisting of O_2 and O_3.

4. A method as claimed in claim 2 wherein the gas plasma oxidation is carried out at a temperature in the range of from about 250° to about 500°C.

5. A method as claimed in claim 1 wherein said high dielectric constant oxide dielectric material is Ta_2O_5.

6. A method as claimed in claim 5 wherein said high dielectric constant oxide dielectric material is amorphous Ta_2O_5.

7. A method as claimed in claim 5 wherein said high dielectric constant oxide dielectric material is crystalline Ta_2O_5.

8. A method of forming a capacitor comprising providing a conductive oxide electrode,

depositing a first layer of a high dielectric constant oxide dielectric material on said conductive oxide electrode, oxidizing said conductive oxide electrode and said first layer of said high dielectric constant oxide dielectric material under oxidizing conditions, depositing a second layer of said high dielectric constant oxide dielectric material on said first layer of said high dielectric constant oxide dielectric material, depositing an upper layer electrode on said second layer of said high dielectric constant oxide dielectric material, and oxidizing said upper layer electrode under oxidizing conditions.

9. A method as claimed in claim 8 wherein said upper layer electrode is oxidized using a gas plasma.

10. A method as claimed in claim 9 wherein said gas plasma oxidation is carried out at a temperature in the range of from about 250° to about 500°C.

11. A method of forming a capacitor comprising providing a conductive oxide electrode, depositing a first layer of a high dielectric constant oxide dielectric material on said conductive oxide electrode, oxidizing said conductive oxide electrode and said first layer of said high dielectric constant oxide dielectric material under oxidizing conditions, depositing a second layer of said high dielectric constant oxide dielectric material on said first layer of said high dielectric constant oxide dielectric material, depositing an upper layer electrode on said second layer of said high dielectric constant oxide dielectric material, depositing a gas permeable electrode on said upper layer electrode, and oxidizing said upper layer electrode.

12. A method as claimed in claim 11 wherein said gas permeable electrode comprises platinum.

13. A method as claimed in claim 11 wherein said upper layer electrode is oxidized by annealing under oxidizing conditions.

14. A method as claimed in claim 13 wherein said upper electrode is annealed at a temperature in the range of from about 350° to about 500°C.

15. A method of forming a capacitor comprising providing a conductive oxide electrode, depositing a first layer of a high dielectric constant oxide dielectric material comprising Ta_2O_5 on the conductive oxide electrode, oxidizing said conductive oxide electrode and said first layer of said high dielectric constant oxide dielectric material under oxidizing conditions, depositing a second layer of said high dielectric constant oxide dielectric material on said first layer of said high dielectric constant oxide dielectric material, oxidizing said second layer of said high dielectric constant oxide dielectric material, and depositing an upper layer electrode on said second layer of said high dielectric constant oxide dielectric material.

16. A method as claimed in claim 15 wherein said second layer of said high dielectric constant oxide dielectric material is oxidized using a gas plasma.

17. A method as claimed in claim 16 wherein said gas plasma is formed using a gas selected from the group consisting of O_2 and O_3.

18. A method as claimed in claim 16 wherein said gas plasma oxidation is carried out at a temperature in the range of from about 300° to about 700°C.

19. A method as claimed in claim 15 wherein said second layer of said high dielectric constant oxide dielectric material is oxidized in a furnace.

20. A method as claimed in claim 19 wherein the furnace oxidation is performed at a temperature of less than about 700°C.

21. A method as claimed in claim 19 wherein the furnace oxidation uses a gas selected from the group consisting of O_2 and N_2O.

22. A method as claimed in claim 15 wherein said second layer of said high dielectric constant oxide dielectric material is oxidized by rapid thermal oxidation.

23. A method as claimed in claim 22 wherein the rapid thermal oxidation is performed at a temperature of less than about 700°C.

24. A method as claimed in claim 22 wherein the oxidation is performed in the presence of a gas selected from the group consisting of O_2 and N_2O.

25. A method as claimed in claim 15 further comprising crystallizing said second layer of said high dielectric constant oxide dielectric material prior to depositing said upper electrode.

26. A method as claimed in claim 25 wherein said second layer of said high dielectric constant oxide dielectric material is crystallized by heating said high dielectric constant oxide dielectric material at a temperature greater than about 700°C in an inert atmosphere.

27. A method as claimed in claim 25 wherein said second layer of said high dielectric constant oxide dielectric material is crystallized and oxidized by heating said high dielectric constant oxide dielectric material at a temperature greater than about 700°C in an atmosphere containing a gas selected from the group consisting of O_2 and N_2O.

28. A method of forming a capacitor comprising providing a conductive oxide electrode, depositing a first layer of a dielectric material comprising Ta_2O_5 on said conductive oxide electrode, treating said conductive oxide electrode and said dielectric

material under oxidizing conditions, depositing a second layer of a dielectric material comprising Ta_2O_5 on said first layer of said dielectric material, oxidizing said second layer of said dielectric material, crystallizing said second layer of said dielectric material, and depositing an upper layer electrode on said second layer of said dielectric material.

29. A method as claimed in claim 28 wherein said second layer of said dielectric material is crystallized by heating at a temperature of greater than about 700°C in an inert atmosphere.

30. A method as claimed in claim 28 wherein said second layer of said dielectric material is crystallized and oxidized by heating at a temperature of greater than about 700°C in an atmosphere containing a gas selected from the group consisting of O_2 and N_2O.

31. A method as claimed in claim 28 wherein said second layer of said dielectric material is oxidized by a gas plasma.

32. A method as claimed in claim 31 wherein said gas plasma oxidation is carried out in a gas selected from the group consisting of O_2 and O_3.

33. A method as claimed in claim 31 wherein said gas plasma oxidation is carried out at a temperature in the range of from about 300° to about 700°C.

34. A method as claimed in claim 28 wherein said second layer of said dielectric material is oxidized in a furnace.

35. A method as claimed in claim 34 wherein the furnace oxidation is carried out at a temperature less than about 700°C.

36. A method as claimed in claim 34 wherein the furnace oxidation is carried out in an atmosphere containing a gas selected from the group consisting of O_2 and N_2O.

37. A method as claimed in claim 28 wherein said second layer of said dielectric material is oxidized by rapid thermal oxidation.

38. A method as claimed in claim 37 wherein said rapid thermal oxidation is carried out at a temperature of less than about 700°C.

39. A method as claimed in claim 37 wherein said rapid thermal oxidation is carried out in an atmosphere containing a gas selected from the group consisting of O_2 and N_2O.

40. A method of forming a capacitor comprising providing a conductive oxide electrode selected from the group consisting of RuO_x and IrO_x, depositing a first layer of a dielectric material selected from the group consisting of Ta_2O_5 and $Ba_xSr_{(1-x)}TiO_3$ on said conductive oxide electrode, oxidizing said conductive oxide electrode and said first layer of said dielectric material with a gas plasma, depositing a second layer of said dielectric material on said first layer of said dielectric material, depositing an upper layer electrode on said second layer of said dielectric material, and oxidizing said upper layer electrode.

41. A method as claimed in claim 40 wherein said conductive oxide electrode and said first layer of said dielectric material are oxidized using a gas selected from the group consisting of O_2 and O_3.

42. A method as claimed in claim 40 wherein the oxidation is carried out at a temperature in the range of from about 250° to about 500°C.

43. A method as claimed in claim 40 wherein said upper layer electrode is oxidized using a second gas plasma in an oxidizing environment.

44. A method as claimed in claim 43 wherein the oxidation of said upper layer electrode is carried out at a temperature in the range of from about 250° to about 500°C.

45. A method as claimed in claim 40 wherein said upper layer electrode is selected from the group consisting of RuO_x and IrO_x.

46. A method as claimed in claim 40 wherein said conductive oxide electrode comprises RuO_x and said first layer of said dielectric material comprises Ta_2O_5.

47. A method as claimed in claim 46 further comprising oxidizing the surface of said conductive oxide electrode prior to depositing said first layer of said dielectric material.

48. A method as claimed in claim 47 wherein the surface of said conductive oxide electrode is oxidized at a temperature in the range of from about 400° to about 475°C.

49. A method as claimed in claim 47 wherein the surface of said conductive oxide electrode is oxidized in an atmosphere containing a gas selected from the group consisting of O_2,O_3, and N_2O.

50. A method of forming a capacitor comprising providing a conductive oxide electrode selected from the group consisting of RuO_x and IrO_x, depositing a first layer of a dielectric material selected from the group consisting of Ta_2O_5 and $Ba_xSr_{(1-x)}TiO_3$ on said conductive oxide electrode, oxidizing said conductive oxide electrode and said first layer of said dielectric material using a gas plasma under oxidizing conditions, depositing a second layer of said dielectric material on said first layer of said dielectric

material, oxidizing said second layer of said dielectric material, depositing an upper layer electrode on said second layer of said dielectric material, and oxidizing said upper layer electrode.

51. A method as claimed in claim 50 wherein said second layer of said dielectric material is oxidized with a gas plasma.

52. A method as claimed in claim 51 wherein said gas plasma is formed from a gas selected from the group consisting of O_2 and O_3.

53. A method as claimed in claim 51 wherein said oxidation is carried out at a temperature in the range of from about 250° to about 500°C.

54. A method as claimed in claim 50 wherein said second layer of said dielectric material is oxidized in a furnace.

55. A method as claimed in claim 54 wherein said furnace oxidation is carried out at a temperature of less than about 700°C.

56. A method as claimed in claim 54 wherein said furnace oxidation is carried out in an atmosphere comprising a gas selected from the group consisting of O_2 and N_2O.

57. A method as claimed in claim 50 wherein said second layer of said dielectric material is oxidized by rapid thermal oxidation.

58. A method as claimed in claim 57 wherein the oxidation is carried out at a temperature less than about 700°C.

59. A method as claimed in claim 57 wherein the oxidation is carried out in an atmosphere containing a gas selected from the group consisting of O_2 and N_2O.

60. A method as claimed in claim 50 wherein said upper layer electrode is oxidized using a gas plasma under oxidizing conditions.

61. A method as claimed in claim 60 wherein the oxidation is carried out at a temperature in the range of from about 250° to about 500°C.

62. A method as claimed in claim 50 further comprising depositing a gas permeable electrode on said upper layer electrode prior to oxidizing said upper layer electrode.

63. A method as claimed in claim 62 wherein said gas permeable electrode comprises platinum.

64. A method as claimed in claim 62 wherein said upper layer electrode is oxidized by annealing under oxidizing conditions.

65. A method as claimed in claim 64 wherein the annealing is carried out at a temperature in the range of from about 350° to about 500°C.

66. A method of forming a capacitor comprising providing a conductive oxide electrode, depositing a first layer of a $Ba_xSr_{(1-x)}TiO_3$ dielectric material on said conductive oxide electrode, oxidizing said conductive oxide electrode and said first layer of said dielectric material with a gas plasma under oxidizing conditions, depositing a second layer of said dielectric material on said first layer of said dielectric material, depositing an upper layer electrode on said second layer of said dielectric material, and oxidizing said upper layer electrode.

67. A method as claimed in claim 66 wherein said first layer of said dielectric material is deposited at a temperature of less than about 650°C.

68. A method as claimed in claim 66 wherein said first layer of said dielectric material is deposited at a temperature in the range of from about 400° to about 500°C.

69. A method as claimed in claim 66 wherein said conductive oxide electrode is selected from the group consisting of RuO_x and IrO_x.

70. A method as claimed in claim 66 wherein said first layer of said dielectric material is deposited at a temperature of less than about 650°C.

71. A method as claimed in claim 66 wherein said second layer of said dielectric material is deposited at a temperature in the range of from about 550° to about 600°C.

72. A method as claimed in claim 66 wherein said upper layer electrode is selected from the group consisting of RuO_x and IrO_x.

73. A method of forming a capacitor comprising providing a conductive oxide electrode depositing a first layer of a high dielectric constant oxide dielectric material on said conductive oxide electrode, oxidizing said conductive oxide electrode and said first layer of said high dielectric constant oxide dielectric material under oxidizing conditions, depositing a second layer of said high dielectric constant oxide dielectric material on said first layer of said high dielectric constant oxide dielectric material, and depositing an upper layer electrode on said second layer of high dielectric constant oxide dielectric material.

74. A method as claimed in claim 73 wherein said high dielectric constant oxide dielectric material is selected from the group consisting of Ta_2O_5 and $Ba_xSr_{(1-x)}TiO_3$.

75. A method as claimed in claim 73 wherein said conductive oxide electrode is selected from the group consisting of RuO_x and IrO_x.

76. A method as claimed in claim 73 wherein said upper layer electrode is selected from the group consisting of RuO_x and IrO_x.

77. A method as claimed in claim 73 wherein said high dielectric constant oxide dielectric material is oxidized using a gas plasma.

78. A method as claimed in claim 77 wherein said oxidation is carried out in an atmosphere containing a gas selected from the group consisting of O_2 and O_3.

79. A method as claimed in claim 77 wherein the oxidation is carried out at a temperature in the range of from about 250° to about 500°C.

80. A capacitor comprising an oxidized conductive oxide electrode, an oxidized first layer of a high dielectric constant oxide dielectric material adjacent said oxidized conductive oxide electrode, a second layer of said high dielectric constant oxide dielectric material adjacent said first layer of said high dielectric constant oxide dielectric material, and an upper layer electrode adjacent said second layer of said high dielectric constant oxide dielectric material, wherein said oxidized conductive oxide electrode and said oxidized first layer of said high dielectric constant oxide dielectric material are oxidized prior to depositing said second layer of said high dielectric constant oxide dielectric material oxide dielectric.

81. A capacitor as claimed in claim 80 wherein said high dielectric constant oxide dielectric material is selected from the group consisting of Ta_2O_5 and $Ba_xSr_{(1-x)}TiO_3$.

82. A capacitor as claimed in claim 80 wherein said oxidized conductive oxide electrode is selected from the group consisting of RuO_x and IrO_x.

83. A capacitor as claimed in claim 80 wherein said upper layer electrode is selected from the group consisting of RuO_x and IrO_x.

84. A capacitor as claimed in claim 80 further comprising a gas permeable electrode adjacent said upper layer electrode.

85. A capacitor as claimed in claim 84 wherein said gas permeable electrode comprises platinum.

86. A capacitor as claimed in claim 80 wherein said first layer of said high dielectric constant oxide dielectric material is between about 20 and about 50Å thick.

87. A capacitor comprising an oxidized conductive oxide electrode selected from the group consisting of RuO_x and IrO_x, an oxidized first layer of a high dielectric constant oxide dielectric material adjacent to said oxidized conductive oxide layer, a second layer of said high dielectric constant oxide dielectric material adjacent to said first layer of said high dielectric constant oxide dielectric material, and an upper layer electrode selected from the group consisting of RuO_x and IrO_x adjacent said second layer of said high dielectric constant oxide dielectric material, wherein said oxidized conductive oxide electrode and said oxidized first layer of said high dielectric constant oxide dielectric material are oxidized prior to the deposition of said second layer of said high dielectric constant oxide dielectric material.

88. A capacitor as claimed in claim 87 wherein said high dielectric constant oxide dielectric material is selected from the group consisting of Ta_2O_5 and $Ba_xSr_{(1-x)}TiO_3$.

89. A capacitor as claimed in claim 87 wherein said first layer of said high dielectric constant oxide dielectric material is between about 20 and about 50Å thick.

90. A capacitor comprising an oxidized conductive oxide electrode, an oxidized first layer of a high dielectric constant oxide dielectric material selected from the group consisting of Ta_2O_5 and $Ba_xSr_{(1-x)}TiO_3$ adjacent said oxidized conductive oxide electrode, a second layer of said high dielectric constant oxide dielectric material adjacent said first layer of said high dielectric constant oxide dielectric material, and an upper layer electrode adjacent said second layer of said high dielectric constant oxide dielectric material, and wherein said oxidized conductive oxide electrode and said oxidized first layer of said high dielectric constant oxide dielectric material are oxidized prior to the deposition of said second layer of said high dielectric constant oxide dielectric material.

91. A capacitor as claimed in claim 90 wherein said oxidized conductive oxide electrode is selected from the group consisting of RuO_x and IrO_x.

92. A capacitor as claimed in claim 90 wherein said upper layer electrode is selected from the group consisting of RuO_x and IrO_x.

93. A capacitor as claimed in claim 90 further comprising a gas permeable electrode adjacent to said upper layer electrode.

94. A capacitor as claimed in claim 93 wherein said gas permeable electrode comprises platinum.

95. A capacitor as claimed in claim 90 wherein said first layer of said high dielectric constant oxide dielectric material is between about 20 and about 50Å thick.

96. A capacitor comprising an oxidized conductive oxide electrode selected from the group consisting of RuO_x and IrO_x, an oxidized first layer of a high dielectric constant oxide dielectric material selected from the group consisting of Ta_2O_5 and $Ba_xSr_{(1-x)}TiO_3$ adjacent to said oxidized conductive oxide layer; a second layer of high dielectric constant oxide dielectric material adjacent to said first layer of said high dielectric constant oxide dielectric material, and an upper layer electrode selected from the group consisting of RuO_x and IrO_x adjacent to said second layer of said high dielectric constant oxide dielectric material, and wherein said oxidized conductive oxide electrode and said oxidized first layer of said high dielectric constant oxide dielectric material are oxidized prior to the deposition of said second layer of said high dielectric constant oxide dielectric material.

97. A capacitor as claimed in claim 96 further comprising a gas permeable electrode adjacent said upper layer electrode.

98. A capacitor as claimed in claim 97 wherein said gas permeable electrode comprises platinum.

99. A capacitor as claimed in claim 96 wherein said first layer of said high dielectric constant oxide dielectric material is between about 20 and about 50Å thick.

100. A method of forming a DRAM cell comprising providing a conductive oxide electrode, depositing a first layer of a high dielectric constant oxide dielectric material on said conductive oxide electrode, oxidizing said conductive oxide electrode and said first layer of said high dielectric constant oxide dielectric material under oxidizing conditions, depositing a second layer of said high dielectric constant oxide dielectric material on said first layer of said high dielectric constant oxide dielectric material, depositing an upper layer electrode on said second layer of said high dielectric constant oxide dielectric material, providing a field effect transistor having a pair of source/drain

regions, electrically connecting one of said source/drain regions with said conductive oxide electrode and electrically connecting the other of said source/drain regions with a bit line.

101. A method as claimed in claim 100 wherein said high dielectric constant oxide dielectric material is oxidized using a gas plasma.

102. A method as claimed in claim 101 wherein said gas plasma is formed from a gas selected from the group consisting of O_2 and O_3.

103. A method as claimed in claim 101 wherein the gas plasma oxidation is carried out at a temperature in the range of from about 250° to about 500°C.

104. A method as claimed in claim 100 wherein said high dielectric constant oxide dielectric material is Ta_2O_5.

105. A method as claimed in claim 104 wherein said high dielectric constant oxide dielectric material is amorphous Ta_2O_5.

106. A method as claimed in claim 104 wherein said high dielectric constant oxide dielectric material is crystalline Ta_2O_5.